State of California The Resources Agency of California

M e m o r a n d u m

To: Commissioner John L. Geesman
Commissioner Jim D. Boyd

Date: October 4, 2005

From: **California Energy Commission, Tom Gorin, Demand Analysis Office**
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Subject: **Supplementary Information on Historic Load Factors**

Commissioner Geesman, presiding commissioner for the *Integrated Energy Policy Report* (IEPR), requested additional information on historic load factors at the June 27 workshop on the Electricity Environmental Performance Report (transcript, p.44) and reiterated his request at the June 30 Electricity Demand Forecast workshop (transcript, p.20). He directed staff to prepare a picture of the trend over the last 25 or 30 years for the state as well as for northern and southern California.

In this preliminary analysis, we were able to look at long-term trends for individual utility service areas, not adjusted for weather, and at statewide, weather-adjusted load factors for a shorter time period. The trends are not uniform across the utility service areas. Declining load factors are evident for Pacific Gas and Electric (PG&E) and Southern California Edison (SCE), while load factors remain fairly constant for San Diego Gas and Electric (SDG&E) and Los Angeles Department of Water and Power (LADWP). Historically, Sacramento Municipal Utility District's (SMUD) load factor has been trending slightly upward, but now is trending downward and projected to decline slightly over the forecast period. On a statewide basis, weather-adjusted load factors appear to have decreased from 56.4 to 55.0 over the last 11 years.

Background

Load factors are used to illustrate whether electricity use is spread more evenly throughout the year or whether it spikes at peak hours. Mathematically, the load factor is calculated by dividing average annual hourly consumption by annual peak consumption. If peak increases faster than annual average consumption, the load factor will decrease. When this happens, different resources and demand side strategies become more cost-effective than they would in a scenario where the load factor is flat or increasing.

Ideally, we would look at service area load factor trends over a long period to account for the natural variability of daily weather. Peak loads are affected by electricity use on the very hottest day, so are obviously very weather sensitive. But annual energy use is also affected by whether the summer was generally hot or cool and whether the winter was warm or cool. Due to data limitations, we have been able to accomplish only portions of the ideal analysis. We have examined 1970-2004 service area trends on a non-weather-adjusted basis and looked at 1993-2004 data on a statewide basis, where we have been able to account for differences in temperature on peak days.

For the pre-1993 period that lacks daily consumption data, we cannot determine the daily relationships between consumption and temperature. The load factor will be different for a year with a cool winter (more electric space heating), moderate summer, and extremely hot peak day than a year with a warm winter, hot summer, but average peak day.

Service Area Load Factors 1970–2004

The following five charts show the long-term, non-weather-adjusted trends for California's five biggest electric utilities. In analyzing why these patterns occurred, we determined that average electrical use patterns have changed as the industrial share of overall load has decreased, as building and appliance efficiency has increased, and as Californians have added new electric equipment to their homes and businesses.

Figures 1 and 2 illustrate the historic and projected trends for PG&E and SCE. PG&E's forecasted trend declines slightly, but remains within the range of recent history.

Figure 1: PG&E Historic Load Factors 1970-2004

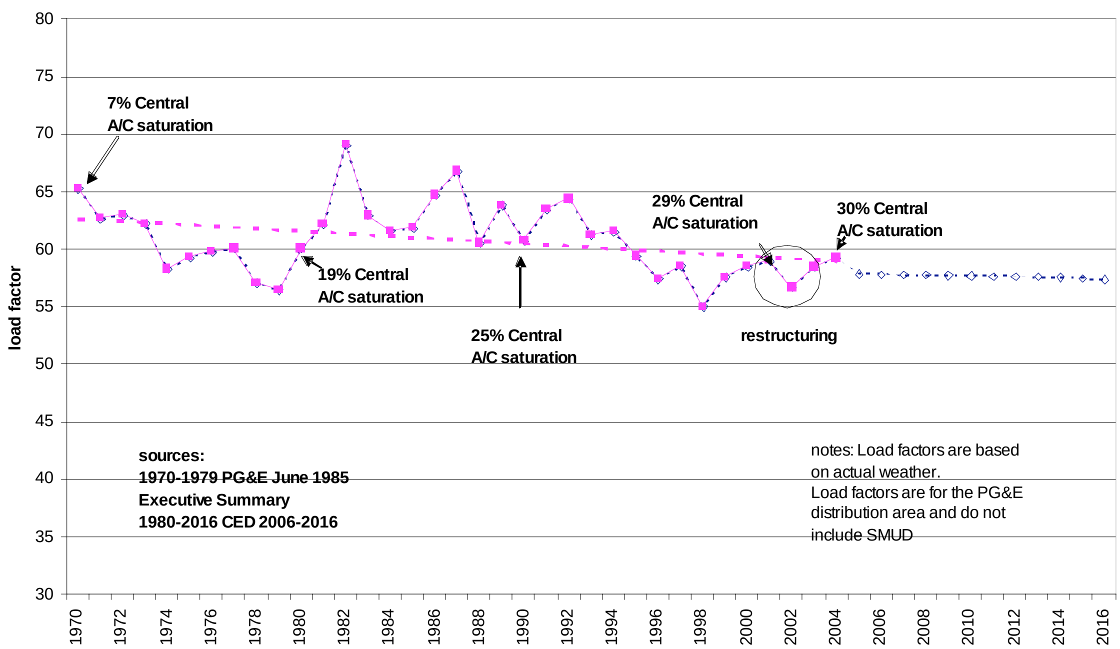
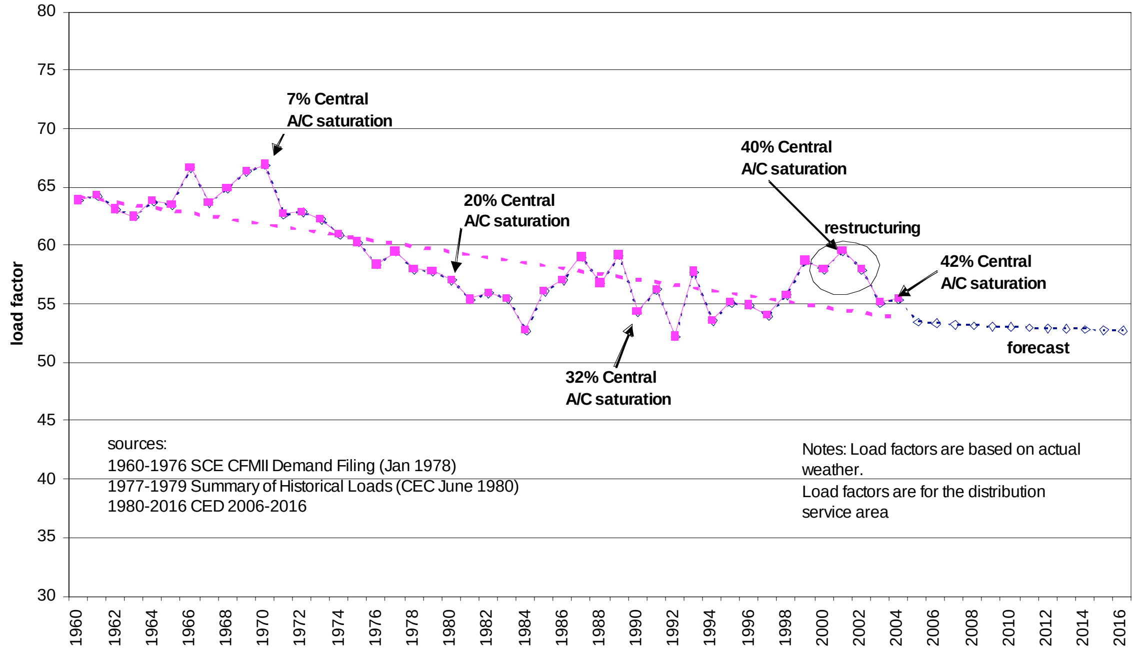


Figure 1 also illustrates how much load factors can vary from year-to-year, which can be very important regarding how much and what type of resources a load serving entity (LSE) must acquire in advance to meet potential need. Weather patterns cannot be predicted very far into the future, so LSEs must plan for potential highs and lows, as well as the long-term trend.

SCE's service area load factor has declined more than PG&E's over the past 34 years. SCE's load factor is currently near 55, while PG&E is just below 60.

Figure 2: SCE Historic Load Factors 1960-2004

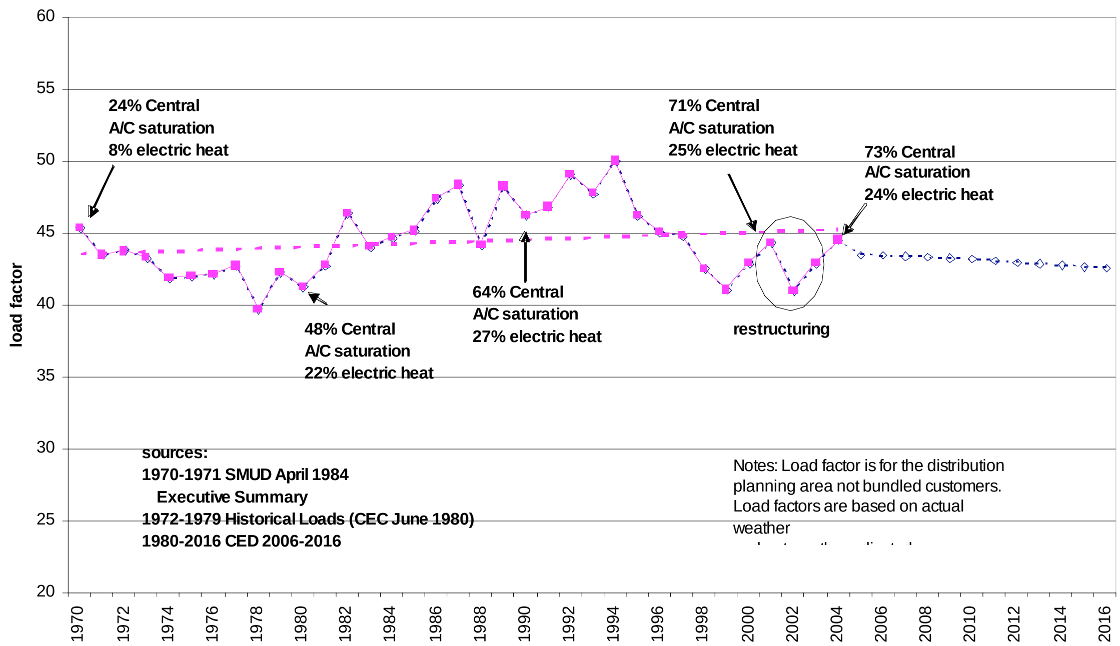


In the 1970s and early 1980s, the spread of central air conditioning in both hotter and coastal areas increased peak summer usage as more floor space was cooled. This trend tended to lower the load factor for both PG&E and SCE. Demand analysts hypothesized that as more houses were built inland, as house size increased, and as electricity bills declined as a percent of total income, more air conditioning would be used, and the residential load factor would decline.

But, this hypothesis is not the only influencing factor, as shown in the flat or rising load factor trends for San Diego, Sacramento, and Los Angeles. The move toward electric heat and all-electric housing in the early 1980s had the counter-balancing impact of increasing load factors.

In areas such as SMUD, where electric heat increased from 1970-1990, the load factor could have increased as average hourly consumption increased in winter months as a result of electric heating. In more recent history, where the saturation of electric heat is declining and the saturation of air conditioning continues to increase, the load factor declines.

Figure 3: SMUD Historic Load Factors 1970-2004



To document how central air conditioning and electric space heating have affected load factors, the service area charts include equipment saturation. For example, in PG&E's service area, only 7 percent of homes had central air conditioning in 1970 compared to 26 percent in 1990 and 30 percent in 2004. During that period, the trend line dropped from a load factor of 63 in 1970 to 60 in 1990. Over that same period, SMUD's load factor remained fairly constant because of the counter-balancing effect of winter electric heat.

SDG&E and LADWP illustrate load factors that remain fairly constant over the historic period. The high load factors observed for SDG&E since 1998 are a product of lower-than-average peak temperatures and reaction to the energy crisis.

Figure 4: SDG&E Historic Load Factors 1972-2004

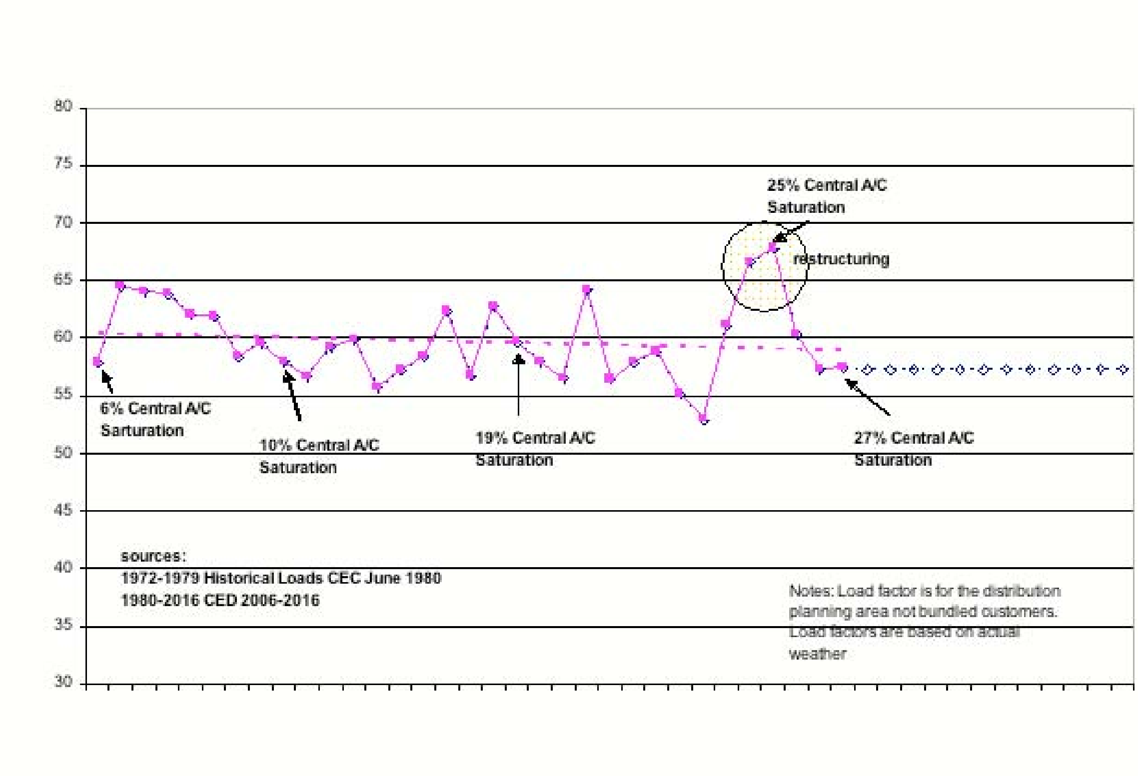
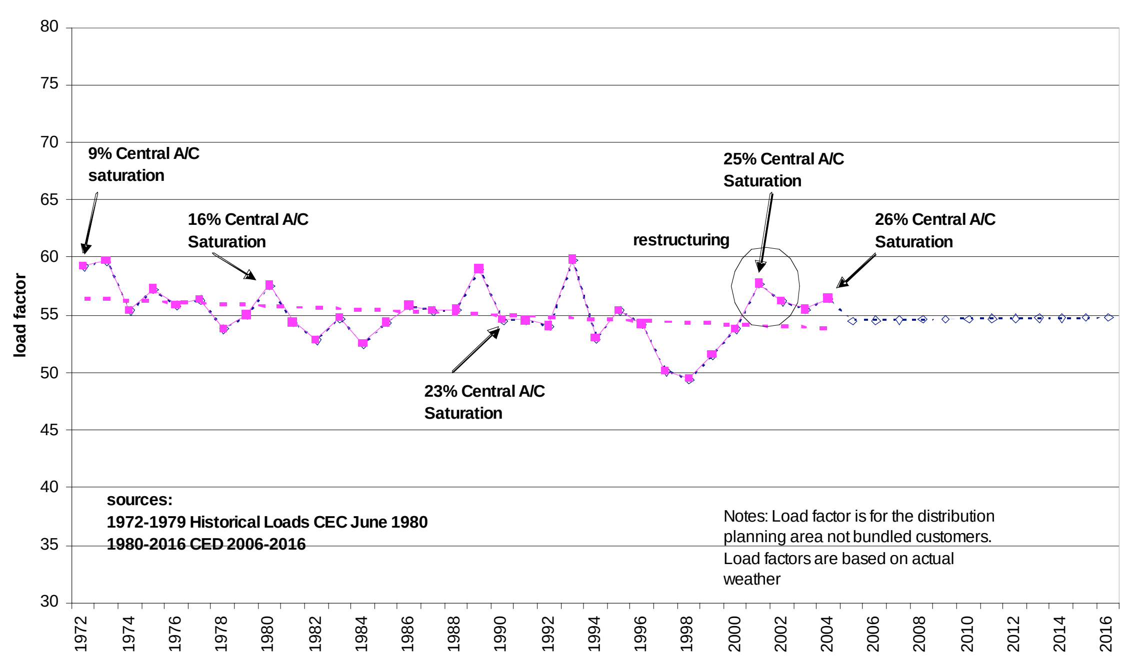


Figure 5: LADWP Historic Load Factors 1972-2004

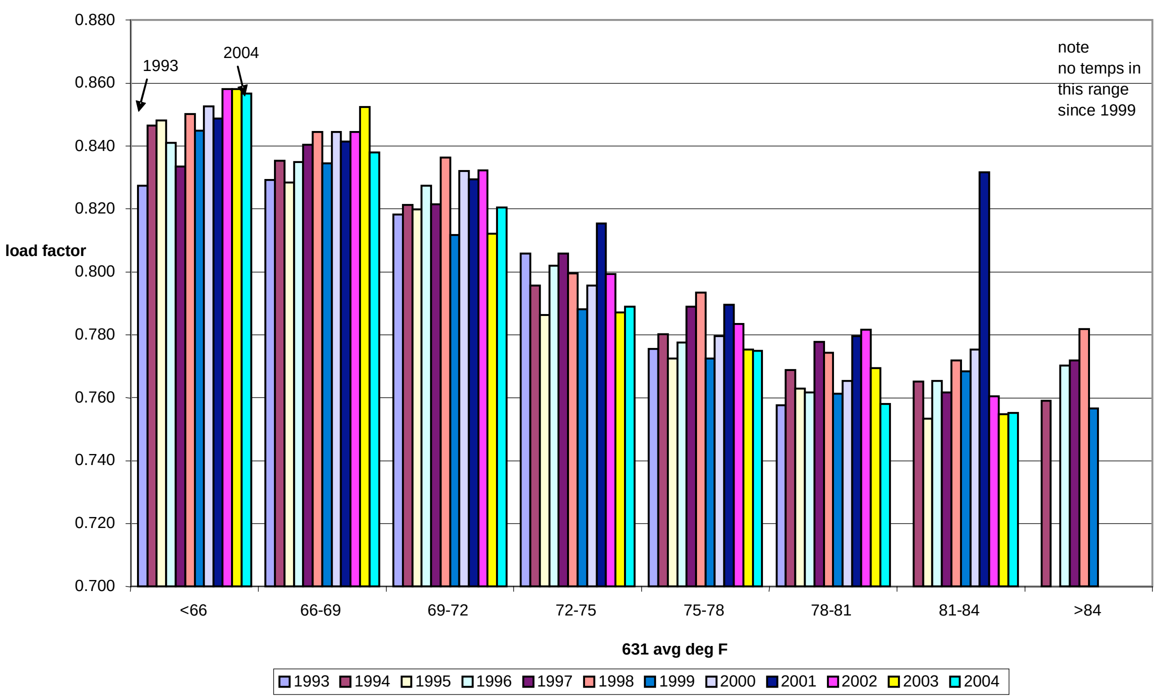


In-Depth Exploration for SCE Territory

Staff has begun to investigate whether other analytic techniques can better explain load factor patterns. In the "temperature bin" method, data is grouped so that we can see whether behavior has changed over the past decades for similarly moderate days, hot days, and very hot days. Comparing average usage on summer weekdays shows whether the daily weekday peak-to-average load relationships have changed over time

In the following chart, average summer weekday load factors were calculated for the SCE planning area by year (colored line) and daily average temperature bins (groupings) for 1993-2004. On summer weekdays in 1993, where the average temperature was less than 66 degrees, the average load factor was 0.825; by 2004, it had increased to 0.857. As we would expect, as temperature increases, the load factor decreases. On the far right, we can see that the average load factor on days on which the average temperature is greater than 84 degrees ranges from 0.758 to 0.781.

Figure 6: SCE Summer Weekday Load Factors by Average Temperature Bins 1990-2004



What is less apparent is a consistent decrease in load factor in the higher temperature bins over the entire period. While the load factors at higher temperature bins have decreased relative to the 2001 levels, they are no lower than they were in the early 1990s. Staff is in the process of adding more historical data to this series and replicating it for other planning areas.

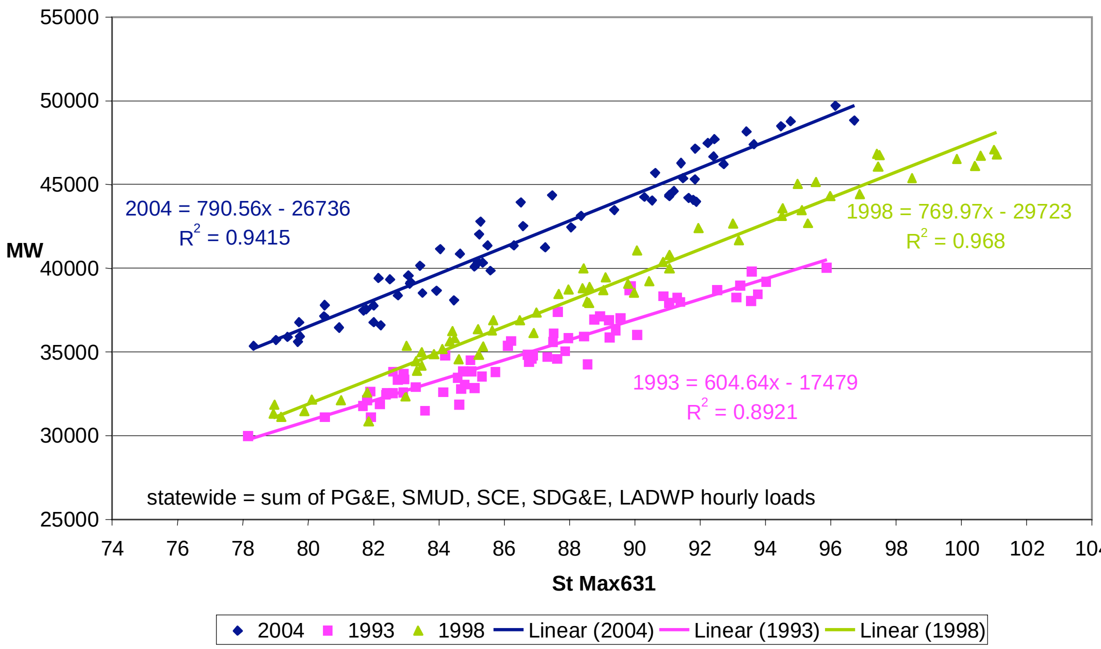
Incidentally, the chart shows that in the 2001 energy crisis, conserving consumers in SCE's planning area sharply reduced their usage, thus increasing that year's load factor even at higher temperatures.

Statewide Weather-Adjusted Load Factors

California's large geographical area and many diverse climates make it difficult to weather adjust demand data on a statewide basis. Northern California usually has its hottest temperatures in July and August, while southern California usually has its hottest temperatures in late August and September. Total statewide peak will be different when the temperature in San Jose is 95 and 75 in Burbank than when those temperatures are reversed, but they would yield the same average temperature.

The chart below compares California weekday summer peaks and statewide lagged maximum temperatures for 1993, 1998, and 2004. The data were compiled using hourly loads for the state's five largest utilities.

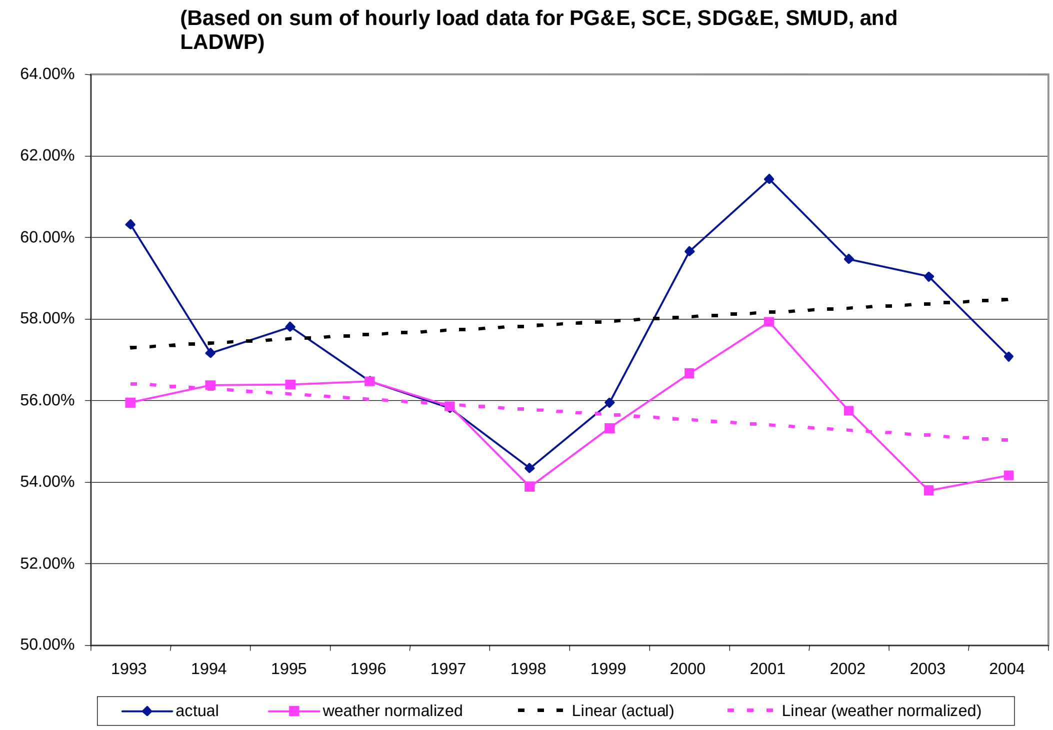
Figure 7: 6/15-9/15 Statewide Peak vs Statewide Three-Day Lagged Maximum Temperature



The upward shift from 1993 to 1998 and 2004 reflects load growth over the period. On a day with a maximum temperature of 90 degrees (based on a statewide index), joint peak loads for the five utilities grew from 36,900 megawatts (MW) in 1993 to 39,600 in 1998 to 44,400 in 2004. Loads have become more sensitive to temperature. A one-degree change in 1993 yielded a 600 MW increase in peak demand, but in 2004 the corresponding change was 790 MW. This increase in MW could be used as a measure of the amount of additional peak needed over a base value for a given temperature.

The final chart (Figure 8) provides actual and weather-normalized statewide load factors for 1993-2004 based on the relationships shown in Figure 7. The data suggest a slight downward trend in the statewide load factor, from 56.41 percent in 1993 to 54.98 percent in 2004, a 2.535 percent drop over the 11-year period from 1993-2004.

Figure 8: Statewide Annual Load Factor, Actual and Weather-Adjusted, 1993-2004



Summary

If daily load factors are increasing over time at lower temperatures (which have lower average loads), as indicated for SCE in Figure 6, and are stable on higher temperature days (which have higher average loads), then the annual load factor will decline.

Actual load factors are overly influenced by the temperature on the hottest weekday of the summer; if the temperature is well below the historical average hottest weekday, electricity demand on that day will be lower than expected, resulting in a higher load factor. As the hottest days in each year during 1999–2005 have been cooler than the historical average, the adjusted load factor, reflecting an estimate of what would have happened had temperatures been at the historical average, is lower.

A single solution or policy to mitigate the slight load factor decline may not exist. At the same time, a declining load factor may be a manageable problem. The peak in California is driven by air conditioning on the few days annually that it is needed in the coastal regions.